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PREDICTIVE VALIDITY OF AN AUTOMATED PERSONALITY INVENTORY FOR AIR FORCE PILOT SELECTION

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To examine the utility of personality testing for enhancing current Air Force pilot selection procedures, a sample of 509 USAF officers was given a computer-administered personality inventory, the Automated Aircrew Personality Profiler (AAPP) prior to entry into Undergraduate Pilot Training (UPT). Factor analysis of 16 scale scores indicated that the inventory comprised measures of five personality characteristics, of which three were directly associated with UPT training outcome (pass or fail): Self-confidence, Values Flexibility, and Hostility. UPT graduates scored higher on both positive dimensions and lower on hostility than did those individuals eliminated for flying training deficiency. The AAPP failed to add predictive utility to a selection model that combined test scores from the Air Force Officer Qualifying Test (AFOQT) and the Basic Attributes Tests (BAT) battery.

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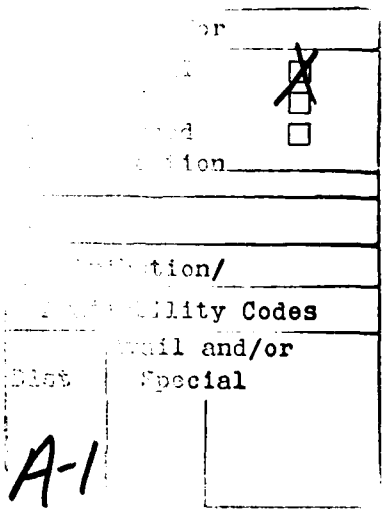

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SUMMARY

A study was conducted to assess whether personality measures could contribute predictive utility to current Air Force pilot selection procedures. A personality inventory was given to a sample of 509 United States Air Force pilot candidates before entry into flying training. The inventory was designed to measure five dimensions thought to be associated with flying performance. Of the five characteristics, three measures were related directly with training outcome: hostility, self-confidence and values flexibility. However, incremental validity analyses did not provide evidence that the inventory could enhance a selection model that combined currently used operational test scores with additional measures from the Basic Attributes Tests (BAT).

PREFACE

This research was completed under Work Unit 77191845, "Development and Validation of Aircrew Selection Methodologies." The work was done in response to Request for Personnel Research (RPR) 78-11, "Selection for Pilot Training."

The author wishes to acknowledge previous efforts on this research project by several people. The inventory would not have existed without the expertise of Dr. John Patterson of the Air Force School of Aerospace Medicine (SAM). Preliminary psychometric analyses were conducted by Dr. Paul Retzloff while he was at the School of Aerospace Medicine. Dr. Edna Fiedler, while serving as a summer research fellow, provided extensive documentation on initial work to examine the predictive utility of the research instrument. Other documentation and data analysis support were provided by Edison Watkins of the OAO Corporation.

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PREDICTIVE VALIDITY OF AN AUTOMATED PERSONALITY INVENTORY FOR AIR FORCE PILOT SELECTION

I. INTRODUCTION

Since World War I, psychological tests have been used for the selection of military aviators in the United States (North & Griffin, 1977). Although measures of personality characteristics were employed in World War I, the trend during and since World War II has been toward a greater reliance on tests of psychomotor coordination and cognitive skills (Imhoff & Levine, 1981). This trend can be explained, in part, by the observation that the tests developed by the Army Air Forces in the 1940s laid the foundation both for the current operational paper-and-pencil test used by the United States Air Force (USAF) and for an experimental computer-administered test battery recently validated for pilot selection (Carretta, 1989). Over the years, standard procedures have evolved for measuring "stick-and-rudder" skills and cognitive abilities such as information processing efficiency and spatial visualization skills. In contrast, no such standardization exists among personality measures. Research into personality characteristics and their relationship to aviation performance has produced a substantial body of literature but has not clearly identified any single instrument for operational use as an aid to military pilot selection (Dolgin & Gibb, 1988).

Several factors may account for this situation. One is the wide variety of predictor and criterion measures used in different studies. Much of the earlier research, for example, focused on the relationship between clinical scales and pilot training measures (e.g., Sells, 1955), whereas more recent studies have employed scales developed for "normal" populations (e.g., Jessup & Jessup, 1971; Novello & Youssef, 1974a, 1974b). Also, several studies have focused on differences between members of the aviation community and the general population (e.g., Ashman & Tefler, 1983; Bartram & Dale, 1982; Fry & Reinhardt, 1969). Others have examined the relationship between pilot characteristics and safety issues (e.g., Sanders & Hoffman, 1975; Sanders, Hoffman, & Neese, 1976; Wichman & Ball, 1983).

Another factor that may account for the lack of a cohesive set of findings concerns a statistical issue. Many studies have examined only simple linear relationships between a large number of intercorrelated personality measures and some criterion. One would expect that the results would vary somewhat from sample to sample--given the same set of measures--simply as a consequence of multicollinearity existing among the predictor measures. Comparison of studies using somewhat different instruments therefore becomes all the more complicated, and rarely has the practice been to extract more global measures from the personality instruments employed.

Despite this lack of conclusive research findings regarding the utility of personality measures for pilot selection, a number of countries currently demonstrate at least an implicit acknowledgment of the importance of personality factors for military pilot selection, as manifested by procedures that involve clinical screening and interview processes (Jones, 1983). Most of those countries can utilize such techniques, requiring intensive screening by highly trained personnel, because of centralized selection procedures. In contrast, pilot candidates for the USAF are drawn from three sources, each of which uses somewhat different selection procedures: the Air Force Academy (AFA), the Air Force Reserve Officer Training Corps (AFROTC), and the Air Force Officer Training School (OTS). Applicants for all three sources are dispersed across a broad geographical area and assignments to pilot training requirements are determined by a number of different selection boards; hence, the need exists for standardized instruments and screening procedures that can be employed in a decentralized fashion.

In response to continued interest in techniques to improve Air Force pilot selection procedures, the present research was designed to evaluate the potential of standardized measures of personality for reducing attrition and enhancing the quality of pilot trainees.

II. METHOD

Sample

The sample consisted of 509 candidates from USAF Undergraduate Pilot Training (UPT). Most of the sample was male (99%; N = 503), and the average age of the pilot candidates was 23.8 years.

Procedure

Pilot applicants were selected into the Air Force on the basis of, in part, achieving minimum scores on the Air Force Officer Qualifying Test (AFOQT). The AFOQT is a paper-and-pencil aptitude battery that includes 16 subtests which are combined into five composites. Two of these composites measure aptitude for pilot training: a Pilot composite and a Navigator-Technical composite (Skinner & Ree, 1987). Prior to entry into flying training, the sample was administered the Automated Aircrew Personality Profiler (AAPP), the instrument used in the present investigation to measure personality characteristics. The AAPP was administered in conjunction with an experimental battery, the Basic Attributes Tests (BAT). The BAT, designed to measure psychomotor coordination and information processing, was administered to the sample subsequent to selection into and prior to Air Force jet pilot training.

The Undergraduate Pilot Training (UPT) program in which respondents participated lasted 49 weeks. The program was composed of two phases of flight training: one in T-37 aircraft and the other in a T-38 aircraft. The T-37 is a subsonic, low-performance jet training aircraft, whereas the T-38 is a high-performance, supersonic jet aircraft. Candidates could be eliminated from training at any point in the program for a variety of reasons. The most common reasons for elimination were flying training deficiency (FTD), medical problems (such as air-sickness), manifestation of apprehension (MOA) and self-initiated elimination (SIE). A smaller number of candidates were eliminated for poor academic performance or insufficient military bearing.

Candidates remaining in the program after 41 weeks of UPT were considered by an Advanced Training Recommendation Board (ATRB)[1] for follow-on instruction in either a fighter-attack-reconnaissance training track (FAR) or a tanker-transport-bomber training track (TTB). The ATRB was a panel of T-38 Instructor Pilots, who determined whether candidates were better suited for fast jet operations (the FAR track) or for flying TTB aircraft. Actual aircraft assignment was a function of three factors: the ATRB outcome, individual preference, and aircraft availability. Information about graduation or reason for elimination, as well as the ATRB recommendation, was collected at the end of UPT.

The number of respondents having data for each of the predictor and criterion measures is shown in Table 1. For some respondents in the sample tested on the personality measure, neither training outcome data nor AFOQT scores were available.

[1]Use of the ATRB for determining follow-on training assignments was discontinued subsequent to UPT class 89-09, which graduated in May 1989. A process of having the Wing Commander make follow-on training assignment decisions began with UPT class 89-10.

Table 1. **Sample Size for Predictor and Criterion Measures**

Measure	Sample size
Basic Attributes Tests	
Item Recognition	509
Encoding Speed	509
Mental Rotation	321
Time-Sharing	509
Self-Crediting Work Knowledge	509
Activities Interest Inventory	509
Automated Aircrew Personality Test	
Air Force Officer Qualifying Test	292
Undergraduate Pilot Training Pass/Fail	325

Instruments

Air Force Officer Qualifying Test. The Air Force Officer Qualifying Test (AFOQT) is a paper-and-pencil test comprised of 16 subtests measuring such factors as pilot aptitude, verbal ability, and math knowledge (Skinner & Ree, 1987). The Pilot composite consists of scores from subtests related to factors such as verbal ability, aviation knowledge, and scale interpretation. The Navigator-Technical composite contains some of the same subtests as the Pilot composite but includes fewer subtest scores related to verbal aptitude and more subtest scores related to quantitative skills (see Appendix).

Basic Attributes Tests. The Basic Attributes Tests (BAT) battery consists of computer-administered tests measuring characteristics such as psychomotor coordination, information processing skills, time-sharing ability, and personality traits. Twelve measures from six tests were included in the present study. For three information processing tests (Item Recognition, Encoding Speed, Mental Rotation), latency and accuracy of item response were recorded. Latencies were also recorded for the other three tests, as were a measure of tracking (Time-Sharing), a measure of self-confidence (Self-Crediting Word Knowledge), and a measure of risk-taking proclivity (Activities Interest Inventory). (For a full description of each test, see Carretta, 1989).

Automated Aircrew Personality Profiler. The Automated Aircrew Personality Profiler (AAPP) consists of 202 items representing scales from several instruments: the Minnesota Multiphasic Personality Inventory (MMPI), one of the more commonly used diagnostic tools in clinical practice (Dahlstrom, Welsh, & Dahlstrom, 1972); the State-Trait Anxiety Inventory (Bucky & Spielberger, 1973); the Personal Orientation Inventory (POI; Knapp, 1975), an instrument designed to assess an individual's aptitude for self-actualization; the Interpersonal Behavior Scale (IBS; Mauger & Adkinson, 1980), which measures assertive and aggressive tendencies; and the Jenkins Activity Survey (JAS; Jenkins, Rosenman, & Friedman, 1967), designed to measure personality factors associated with chronic heart disease.

III. RESULTS

Descriptive Statistics. Descriptive statistics for data from 16 scales of the AAPP are shown in Table 2. The scale scores manifested acceptable variability, and each was normally distributed. There were no cases with either missing data or extreme scores.

Table 2. **AAPP Scale Means and Standard Deviations (N = 509)**

Scale	Mean	SD	Range
Manifest Hostility	8.52	2.56	2 - 15
Acceptance of Aggression	7.53	1.59	3 - 12
Frankness	3.14	1.12	0 - 5
Need for Affection	7.01	1.90	1 - 11
Denial of Social Anxiety	3.91	1.80	0 - 6
Social Imperturbability	8.16	1.95	0 - 11
Naivete	4.95	1.86	0 - 8
Imperturbability	4.33	1.33	0 - 7
Distrust	6.10	1.98	1 - 12
Poignancy	2.07	1.14	0 - 6
Brooding	1.82	1.27	0 - 7
Ego Inflation	4.61	1.50	1 - 9
Values Flexibility	5.66	1.76	1 - 11
Amorality	2.36	1.13	0 - 6
Hypomania	9.72	2.34	4 - 17
Hard Driving	3.03	.98	0 - 5

Factor Analysis

The 16 scale scores from the AAPP were factor analyzed using principal factoring with oblique rotation. Five factors emerged with eigenvalues greater than 1.0 on which all but one scale (Amorality) manifested factor loadings with an absolute value greater than .30 (see Table 3).

Based on the exploratory factor analysis, five personality scores were computed. Each of the five measures was derived in accordance with the factor loadings by combining the unweighted raw scores for each of the component scales. Scales with negative factor loadings were reverse scored before being summed into the factor scores. Descriptive statistics for the five derived measures are reported in Table 4, and their intercorrelations are shown in Table 5. As the intercorrelations demonstrate, the socially desirable factors (self-confidence, values flexibility) were independent of each other and each was negatively correlated with the three less socially desirable factors (hostility, depression, mania). The latter three factors, in contrast, were all positively correlated with one another. These relationships, then, indicate that individuals who were either self-confident or flexible in their values tended not to be hostile, depressed or manic. Similarly, individuals who reported being hostile also reported high levels of depression and mania as well as low levels of self-confidence and values flexibility.

Table 3. **Scale Composition of Five Personality Factors (N = 509)**

Scale	Factor				
	Hostility	Self-confidence	Values flexibility	Depression	Mania
Manifest Hostility	69				
Need for Affection	-68				
Naivete	-92				
Distrust	68				
Ego Inflation	35				
Frankness		36			
Denial of Social Anxiety		84			
Social Imperturbability		-99			
Imperturbability		55			
Acceptance of Aggression			66		
Values Flexibility			64		
Poignancy				57	
Brooding				69	
Amorality[a]					
Hypomania					67
Hard Driving					35
Eigenvalues (Principal Components)	4.69	2.15	1.37	1.10	1.02
% of Variance Explained	29.3	13.3	8.6	6.9	6.5
Eigenvalues (Rotated Factors)	4.30	1.81	.82	.60	.42
% of Variance Explained	26.9	11.3	5.1	3.8	2.6

[a]Only factor loadings with absolute value > .30 are shown.

Table 4. **Descriptive Statistics for Five Personality Factors (N = 509)**

Factor	Mean	SD	Range
Hostility	33.06	9.96	9 - 63
Self-confidence	19.54	4.98	2 - 29
Values Flexibility	13.20	2.81	6 - 21
Depression	3.89	2.04	0 - 11
Mania	12.75	2.75	6 - 21

Table 5. **Intercorrelations of Five Personality Factors (N = 509)**

Factor	1.	2.	3.	4.	5.
1. Hostility	--				
2. Self-confidence	-32**	--			
3. Values Flexibility	-24**	04	--		
4. Depression	40	-33**	-06	--	
5. Mania	44**	-11*	-18**	22**	--

Note. Decimals omitted.
* $p < .05$ that variation from zero correlation is due to chance.
** $p < .01$ that variation from zero correlation is due to chance.

Relationship Between UPT Pass/Fail and Personality Factor Scores

The point-biserial correlations between the five personality factors and UPT training outcome (pass/fail) are shown in Table 6. As these data indicate, three of the scales were associated with UPT outcome. UPT graduates--compared to those who did not complete UPT--tended to be less hostile, more self-confident, and more flexible in their values. The graduation rate was greater than 80%, so that the p/q split for this sample was .82/.18. Thus, the maximum correlation that could result from these data was about .7 (Gradstein, 1986).

Incremental Validity

Analyses reported to this point were designed to address the question of whether personality scores derived from the AAPP demonstrated a relationship with UPT training outcomes. From an operational perspective, an additional question also needs to be addressed: Does the AAPP contribute any unique predictive utility to current or proposed selection models? To address this question, additional data were examined that consisted of other test scores from an operational instrument (the AFOQT) and from an experimental test battery validated for pilot selection, the BAT. The experimental tests from the BAT were Item Recognition, Encoding Speed, Mental Rotation, Time-Sharing, Activities Interest Inventory, and Self-Crediting Word Knowledge. These tests provided measures of speed and accuracy of information processing, self-confidence, risk-taking propensity, and the ability to perform two tasks simultaneously.

Table 6. **Correlations of Five Personality Factor Scores with UPT Outcome (N = 325)**

Personality factor score	UPT pass/fail
Hostility	-.12*
Self-confidence	.13**
Values Flexibility	.12*
Depression	-.10
Mania	-.02

* $p < .05$ that variation from zero correlation is due to chance.
** $p < .01$ that variation from zero correlation is due to chance.

To examine whether the AAPP contributed predictive utility over and above that provided by the AFOQT and BAT scores, a multiple regression analysis was conducted. The criterion was a dichotomous variable representing training outcome (graduate/non-graduate). The predictor set consisted of scores for the Pilot and Navigator-Technical composites of the AFOQT, scores from six experimental tests, as well as five scores from the AAPP. The full model consisted of 19 predictors: two AFOQT composites, 12 BAT measures, and five AAPP scores.

The regression analysis indicated that the full model was significant ($R = .33$, $F[19, 261] = 1.69$, $p < .05$). Elimination of the five personality scores did not significantly reduce the predictability of the model ($R = .29$, F change $[5, 261] = 1.52$, $p < .18$). Based on those results, then, it appeared that the AAPP did not contribute unique predictive validity to a model incorporating both present and planned selection system test scores.

The above analysis provided a fairly conservative test of the contribution of the AAPP to a model predictive of UPT outcome, as the reduced model included two tests measuring personality constructs (Self-Crediting Word Knowledge [SWK] and Activities Interest Inventory [AII]). To provide additional information about the capability of the AAPP to contribute to a selection system, two additional regression analyses were conducted. In one, the predictor set consisted of the full model as described above, except that scores from Self-Crediting Word Knowledge were removed from consideration; the second full model was constrained even further with the removal of scores from the Activities Interest Inventory. The restricted models for both analyses removed the five AAPP scores from the respective full models. The results of these analyses paralleled the findings reported previously: The AAPP did not add significant predictive variance to either the non-SWK model (F change $[5, 268] = 1.68$, $p < .26$) or the non-SWK/AII model (F change $[5, 270] = 1.42$, $p < .22$).

IV. CONCLUSIONS

The main finding from the present study was that the use of self-report personality scores did not enhance the predictive validity of a selection system comprised of a combination of operational tests and experimentally validated measures. The personality measures used in this study demonstrated a weak relationship with UPT pass/fail, which suggests that there is little relationship between self-report measures and pilot performance, as reported previously (Dolgin & Gibb, 1988). Based on the present data, future research might benefit more from utilization of performance-based personality measures, such as the Self-Crediting Word Knowledge test, than on the use of self-report personality tests.

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APPENDIX A: SUBTESTS FROM THE AIR FORCE OFFICER QUALIFYING TEST (AFOQT)

	Composite			
Subtest	Verbal	Quantitative	Navigator-Technical	Pilot
Verbal Analogies	X			X
Arithmetic Reasoning		X	X	
Reading Comprehension	X			
Data Interpretation		X	X	
Word Knowledge	X			
Math Knowledge		X	X	
Mechanical Comprehension			X	X
Electrical Maze			X	X
Scale Reading			X	X
Instrument Comprehension				X
Block Counting			X	X
Table Reading			X	X
Aviation Information				X
Rotated Blocks			X	
General Science			X	
Hidden Figures			X	

Note. A fifth composite, Academic Aptitude, consists of all subtests from the Verbal and Quantitative composites.